Table 7-18. Extrapolations required for developing TRVs.[a]

Extrapolation	Example
Between taxonomic groups	From laboratory mouse to field mouse
Between responses to stressor	From mortality in dogs to a no-observed-effect-level in bobcats
Between laboratory and field conditions	From cage to steppe
Between individual animals to population	From decreased growth rate in captive individuals to effects on a wild population
Between short- and long-term exposure conditions	From acute or subchronic toxicity tests to lifetime exposure
Between laboratory and natural exposure media	Percent uptake of chemical mixed with laboratory diet vs. adsorbed to soil
Between spatial scales	Evaluation of the impact of exposure to a contaminated field on predators whose foraging range is 50 times as large

a. Adapted from EPA (1992).

Our lack of knowledge of environmental variables and limited ability to replicate them in the laboratory or control them in the field results in a high level of uncertainty in our predictions of the effects of stressors on any given ecosystem component from laboratory toxicity tests.

7.4   Risk Characterization

Risk characterization is the final step of the WAG ERA process. The risk evaluation indicates whether there is any indication of risk due to the contaminant concentrations and exposure parameter-calculated dose for INEEL functional groups, T/E, and sensitive species and discusses the uncertainty inherent in the assessment.

For a WAG ERA, the evaluation step has two components starting with a description of the estimation of risk. A summary of the risk evaluation follows the risk estimation. These two components are described in the following sections.

7.4.1   Risk Estimation

This section discusses the estimation of risk. Exposure parameters used to calculate dose to functional groups, T/E, and sensitive species are outlined in Section 7.2. HQs are calculated using the following equation:

$$HQ = \frac{Dose}{TRV}$$

where

HQ = hazard quotient (unitless)

$Dose$ = dose from all media (mg/kg-day or Gy/day)

TRV = TRV (mg/kg-day or Gy/day).

HQs are derived for all contaminants, functional groups, T/E, and sensitive species identified in WAG 4 for each site of concern. The results of the dose calculations are presented in Appendix K. The HQs from the results of the risk analysis are presented in Appendix K. If information was not available to derive a TRV, then an HQ could not be developed for that particular contaminant and functional group or sensitive species combination. These are indicated in the Appendix K tables.

An HQ greater than the target value indicates that exposure to a given contaminant (at the concentrations and for the duration and frequencies of exposure estimated in the exposure assessment) may cause adverse health effects in exposed populations. However, the level of concern associated with exposure may not increase linearly as HQ values exceed the target value. This means that the HQ values cannot be used to represent a probability or a percentage, since an HQ of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ, the greater the concern about potential adverse effects to ecological receptors.

Exposure point concentrations were calculated in accordance with EPA guidance for calculating concentrations terms (EPA 1992b). The calculated exposure point concentrations correspond to the upper 95 percent confidence limit (95% UCL) of the mean for each of the COPC data sets evaluated. As part of the analysis, all data sets are assumed to have log normal distribution.

EPA (1989a) risk assessment guidance recommends consideration of the positively detected results together with the non-detected results (i.e., sample quantitation limits). For this analysis all results reported as "non-detect," the full sample quantitation limit was assumed as a conservative proxy concentration for each sample with a result below the detection limit.

If the calculated 95% UCL of a chemical in a medium-specific data set exceeds the maximum concentration detected in that data set, EPA (1989a) recommends that the maximum detected concentration be selected as the exposure point concentration. Exceedance of the maximum detected concentration typically occurs when dilution effects have resulted in reporting of very high sample quantitation limits (i.e., non-detect values) or if a limited number of sample results are available (e.g., less than ten).

Soil concentration data calculated in the human health risk assessment were used to assess each site. The use of human health concentration data is assumed to be representative of the range of concentrations to which ecological receptors using a site at WAG 4 are likely to be exposed. If the dose from the contaminant does not exceed its TRV (i.e., are less than 1 for nonradiological contaminants) adverse effects from exposure to that contaminant by ecological receptors are not expected, and no further evaluation of that contaminant is required. Hence, the HQ is an indicator of potential risk.

7.4.2 Uncertainty Association with Hazard Quotients

For the WAG ERA, an HQ is used as an indicator of risk and as a trigger for further evaluation of the site. HQs are ratios of the calculated dose for a receptor from COPCs to the TRV. These ratios provide a quantitative index of risk to defined functional groups or individual receptors under assumed exposure conditions. The ratio or hazard quotient method is commonly used in both human health and ecological risk assessments. It is used in the WAG ERA to eliminate contaminants and sites as a risk to the ecosystem at a WAG level, including sites and contaminants that should be subsequently assessed.

In general, the significance of exceeding a target HQ (see Table 7-13) depends on the perceived "value" (ecological, social, or political) of the receptor, the nature of the endpoint measured, and the degree of uncertainty associated with the process as a whole. Therefore, the decision to take no further action, consider corrective action, or perform additional assessment should be approached on a site-, chemical-, and species-specific basis. Because the unit of concern in ecological risk assessment is usually the population as opposed to the individual (EPA 1992), exceeding conservative screening criteria does not necessarily mean that significant adverse effects are likely.

An HQ less than the target value, which is traditionally 1.0 for non-radionuclide contaminants, implies a Alow likelihood≅ of adverse effects from that contaminant. The HQ target is 1 for nonradionuclides and 0.1 for radionuclides. Nonradiological and radiological contaminants are treated separately, since these two classes of contaminants cause different effects in exposed receptors. Effects from the nonradioactive metals are expected to cause systemic toxicity, while the effects to reproductive processes are typically associated with exposure to ionizing radiation. A separate approach in which the target HQ is set to 1/n, where n is the number of nonradiological or radiological contaminants of concern, could also be used, while the HQ could be set at 0.1 (1/10) for the radiological contaminants. This approach would be too conservative for nonradiological contaminants since it assumes cumulative (simultaneous) exposure to all nonradionuclides and that all contaminants within a given group behave synergistically in a given receptor. Given that all receptors within a functional group may not be simultaneously exposed to all contaminants, and that a synergistic effect may not be seen, this approach may be more stringent than necessary to protect all ecological receptors from nonradiological effects. Therefore, the HQ is set to 1 for all nonradiological contaminants. This method may underestimate the risk in that it does not account for cumulative exposure to multiple contaminants by a given receptor. Or this approach may be more realistic given the amount of conservatism already built into the determination of exposure. The HQ target for radionuclides will be set at 0.1, however. Radionuclides have a greater potential for cumulative dose and the development of TRVs for radionuclides was less conservative than for the nonradiological contaminants.

At this level in the ERA approach at the INEEL, both exposure and toxicity assumptions are generally "worst-case," and represent the upper bound of potential risks to ecological receptors. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. Hazard quotients provide essentially a "yes or no" determination of risk and are therefore appropriate for screening-level assessments (EPA 1988b). A limitation of the quotient method is that it does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA 1988b). However, "modified quotient methods" are available that attempt to address this issue. Barnthouse et al. (1986) uses a method in which the conclusions are expressed as "no concern," "possible concern," and "high concern," depending on the ratio of the contaminant concentration to the reference. However, this is not useful in all cases due to specific contaminant characteristics.

A summary of the WAG ERA results is provided in Table 7-19. This table shows the order of magnitude for the largest observed HQ across all functional groups within the site up to an order of 1,000. The actual range of the HQs across functional groups within a site may vary by at least three orders of magnitude. The raw HQ results are shown in Appendix K.

7.4.3 Results of Hazard Quotient Assessment

This section describes the results of the HQ assessment associated with exposure of the functional groups, T/E, and species sensitive to contaminants at WAG 4 sites.

Of the CFA sites assessed in the HQ step of the WAG 4 ERA, fourteen sites out of 29 sites were eliminated. The sites that were eliminated are CFA-12, -15, -23, -24, -27, -28, -30, -31, -34, -37, -38, -44, -45, and -48. The remaining 15 sites have HQs greater than 1.0 for nonradiological contamination. Based on the WAG ERA assumptions and methodology, arsenic, chromium, copper, lead, and mercury soil contamination were identified as the most common nonradiological contaminants with HQs greater than 1.0 at WAG 4. The retained sites are CFA-01, -02, -04, -05, -06, -08, -10, -13, -17/47, -21, -26, -40, -41, -43, and -51. Following is a discussion of the sites based on the information provided in Table 7-19.

CFA-01, Landfill I, has HQs greater than 1.0 from benzo(a)pyrene, chromium III, copper, lead, silver and zinc exposure. The maximum concentration for B(a)P is 0.89 mg/kg. The maximum chromium III concentration is 53 mg/kg. The HQs for B(a)P and chromium III ranges from <1 to 2. The maximum copper concentration is 73.4 mg/kg and the HQ ranged from <1 to 30. The maximum lead concentration is 38 mg/kg and the HQ ranged from ≤ 1 to 100. The maximum silver concentration is 19.5 mg/kg within an HQ between ≤ 1 and 4. The maximum zinc concentration is 230 mg/kg with an HQ between < 1 and 30.

CFA-02, Landfill II, has HQs greater than 1.0 from arsenic, lead, mercury, acetone, benzo(b)fluoranthene, and benzo(k)fluoranthene exposure. The maximum concentration for arsenic is 16 mg/kg. The maximum concentration for lead is 210 mg/kg. The maximum concentration for B(b)F is 0.89 mg/kg with an HQ of < 1 to 1. The maximum concentration for B(k)F is 1.2 mg/kg with an HQ of < 1 to 2. The maximum-observed concentration for mercury, 0.08 mg/kg, only slightly exceeds its background concentration of 0.074 mg/kg, 95%/95% UTL for grab samples (Rood et al 1996). The maximum acetone concentration, 5.8 mg/kg, at 5 ft below grade, is over 10 times higher than the

Table 7-19. Summary of WAG 4 ERA HQ assessment. HQs reported in order of magnitude.

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-01	Landfill I 4.30E+04	Benzo(a)pyrene	≤1 to 2	0.89	—[c]	0.89	SS	No toxicity reference value (TRV) for plants, reptiles or birds.
		Benzo(b)fluoranthene	<1	0.21	—	0.21	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	0.16	—	0.16	SS	Used benzo(a)pyrene values.
		Benzo(k)fluoranthene	<1	0.2	—	0.2	SS	Used benzo(b)fluoranthene values for plants, reptiles and birds.
		Chromium III	≤1 to 50	53	—	53	SS	No TRV for reptiles. Screening benchmark concentration (SBC) (1 mg/kg or 0.05 mg/L) used for plants (HQ = 50 for plants only).
		Chrysene	<1 to 200	450	—	260	SS	No TRV for plants, birds or reptiles.
		Copper	<1 to 30	73.4	—	73.4	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Dibenz(a,h)anthracene	<1	0.38	—	0.38	SS	Used benzo(a)pyrene values.
		Indeno(1,2,3-cd)pyrene	<1	0.083	—	0.083	SS	Used benzo(a)pyrene values.
		Lead	≤1 to 200	97	97	96.5	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	≤1 to 6	0.08	0.08	0.08	S&SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Silver	≤1 to <10	19.5	—	19.5	SS	No TRV for reptiles. SBC (2 mg/kg or 0.1 mg/L) used for plants.
		Zinc	≤1 to 30	230	—	230	SS	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.
CFA-02	Landfill II 7.07E+05	Arsenic	≤1 to 20	17.0	5.8	17	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Lead	≤1 to 950	255	15	188	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Mercury	≤1 to 20	0.19	0.08	0.08	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		2-methylnaphthalene	NA	0.05	—	0.05	SS	Used benzo(a)pyrene values.
		4-methyl-2-pentanone	NA	0.02	—	0.02	SS	No TRVs for any ecological receptor.
		Acetone	≤1 to 20	5.8	0.017	5.8	S & SS	No TRV for plants, reptiles or birds
		Benzo(a)pyrene	<1	0.59	—	0.59	SS	No TRV for plants, reptiles or birds.
		Benzo(b)fluoranthene	≤1 to 1	0.89	—	0.89	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	0.52	—	0.52	SS	Used benzo(a)pyrene values
		Benzo(k)fluoranthene	<1 to 1	1.2	—	1.2	SS	Used benzo(a)pyrene values.
		Chrysene	<1	0.92	—	0.92	SS	No TRV for plants, reptiles or birds.
		Dibenz(a,h)anthracene	<1	0.38	—	0.38	SS	Used benzo(a)pyrene values.
		Dibenzofuran	NA	0.039	—	0.039	SS	No TRV for any ecological receptors.
		Indeno(1,2,3-cd)pyrene	<1	0.65	—	0.65	SS	Used benzo(a)pyrene values.
		Pentachlorophenol	NA	0.074	—	0.074	SS	No TRV for reptiles, birds or mammals. SBC (3 mg/kg or 0.03 mg/L) used for plants.
CFA-04	Pond near CFA-674 6.88E+03	Arsenic	≤1 to 20	22.4	7.63	22.4	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Barium	≤1 to 6	1120	240	530	S & SS	No TRV for reptiles or birds. SBC (500 mg/kg) used for plants.
		Cadmium	≤1 to 1,000	3.4	3.4	2.15[d]	S & SS	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.
		Chromium III	<1 to 100	237	237	27	S & SS	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Cobalt	≤1 to 20	10	10	10	S & SS	No TRV for reptiles. SBC (20 mg/kg or 0.06 mg/L) used for plants.
		Copper	≤1 to 150	365	136	-	S	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	≤1 to 90	42.4	42.4	21.0	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Mercury	<1 to 30,000	439	439	147	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	<1 to 110	355	87	34	S & SS	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		Nitrate	<1	11	11	2.9	S & SS	No TRV for plants or reptiles.
		Silver	≤1 to 20	31	31	ND	S	No TRV for reptiles. SBC (2 mg/kg) used for plants.
		Vanadium	≤2 to 200	46	39	46	S & SS	No TRV for reptiles. SBC (2 mg/kg or 0.2 mg/L) used for plants.
CFA-05 (ditch)	Motor Pool Pond 7.43E+03	Aroclor-1254	<1 to 1	2.8	2.8	0.0	S	No TRV for reptiles. SBC (40 mg/kg) used for plants.
		Arsenic	≤1 to 5	19.8	18.4	15.5	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants
		Barium	<1	434	434	311	S & SS	No TRV for reptiles or birds. SBC (500 mg/kg) used for plants.
		Cadmium	<1 to 4,000	38.8	38.8	—	S	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.
		Chromium III	≤1 to 90	91.3	91.3	—	S	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Cobalt	≤2 to 20	6.7	6.7	13.8	S & SS	No TRV for reptiles. SBC (20 mg/kg or 0.06 mg/L) used for plants.
		Copper	≤1 to 40	342	342	—	S	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	≤1 to 200	464	464	270	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Manganese	≤1 to 14	617	155	617	S & SS	No TRV for reptiles. SBC (500 mg/kg or 4 mg/L) used for plants.
		Mercury	≤1 to 9	0.58	0.58	0.58	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	≤1 to 3	36.7	22.8	31.7	S & SS	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected	Data Gaps[a]
		4-methyl-2-pentanone	NA	0.065	0.065	—	S	No TRV for any ecological receptor.
		Silver	<1	6.5	2.7	0.6	S & SS	No TRV for reptiles. SBC (2 mg/kg) used for plants.
		Selenium	<1 to 5	1.1	1.1	0.9	S & SS	No TRV for reptiles. SBC (0.1 mg/kg) used for plants.
		Vanadium	<1 to 20	34	28.5	26	S & SS	No TRV for reptiles. SBC (0.2 mg/kg) used for plants.
		Zinc	<1 to 20	241	97.2	160	S & SS	No TRV for reptiles. SBC (0.4 mg/kg) used for plants.
CFA-06	Lead Shop (outside areas) 2.5E+03	Arsenic	≤1 to 10	14.5	14.5	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.001 mg/L) used for plants.
		Lead	≤1 to 200	153	153	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield 1.85E+04	Arsenic	≤1 to 10	16.8	11.4	16.8	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Chromium III	<1 to 80	77.6	77.6	62.0	S & SS	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Copper	≤1 to 20	56.5	33.0	27.5	S & SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	≤1 to 40	18	18	8.8	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	≤1 to 30	0.51	0.51	0.34	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	≤1 to 20	90.3	90.3	16	S & SS	No TRV or reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		Selenium	<1 to 7	0.5	0.5	—	S	No TRV for reptiles. SBC (1 mg/kg or 0.1 mg/L) used for plants.
		Silver	≤1 to ≤10	24.1	24.1	5.1	S & SS	No TRV for reptiles. SBC (2 mg/kg or 0.1 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[a]
CFA-10	Transformer Yard Oil Spills 8.08E+02	Aroclor-1254	<1	1.3	0.67	1.3	S & SS	No TRV for reptiles. SBC (40 mg/kg) used for plants.
		Benzo(a)pyrene	<1	0.042	0.042	—	S	No TRV for plants, reptiles or birds.
		Chloromethane	NA	0.005	—	0.005	SS	No TRV for any ecological receptors.
		Antimony	<1 to 4	9.5	9.5	—	S	No TRV for reptiles or birds. SBC (5 mg/kg) used for plants.
		Arsenic	<1 to 8	11.6	11.6	—	S	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Cadmium	≤1 to 2,000	7.3	7.3	—	S	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants
		Chromium III	<1 to 100	102	102	—	S	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants
		Cobalt	≤1 to 20	15.7	15.7	—	S	No TRV for reptiles. SBC (20 mg/kg or 0.06 mg/L) used for plants.
		Copper	<1 to 70	259	259	—	S	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	<1 to 5000	5,560	5,560	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Manganese	≤1 to 20	509	509	—	S	No TRV for reptiles. SBC (500 mg/kg or 4 mg/L) used for plants.
		Mercury	<1 to 4	0.09	0.09	—	S	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	≤1 to 20	111	111	—	S	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		Zinc	≤1 to 70	1,150	150	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.
		Aroclor-1254	<1	1.4	1.4	—	S	No TRV for reptiles. SBC (40 mg/kg) used for plants.
CFA-12	Two French Drains (CFA-690) 1.34E+01	Pentachlorophenol	NA	0.25	—	0.25	SS	No TRVs for any ecological receptors.

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Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[c]	Data Gaps[c]
CFA-13	Dry Well (South of CFA-640) 2.50E+01	Antimony	<1 to 3	11.5	—	11.5	SS	No TRV for reptiles or birds. SBC (5 mg/kg) used for plants.
		Aroclor-1254	<1	10	—	10	SS	No TRV for reptiles. SBC (40 mg/kg) used for plants.
		Arsenic	<1 to 1	10.9	—	10.9	SS	No TRV for reptiles. SBC (10 mg/kg or 0.02 mg/L) used for plants.
		Benzo(a)anthracene	<1	9	—	9	SS	No TRV for plants, reptiles or birds.
		Benzo(b)fluoranthene	<1	4.2	—	4.2	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	5.1	—	5.1	SS	Used benzo(a)pyrene values.
		Benzo(k)fluoranthene	<1	3.2	—	3.2	SS	Used benzo(a)pyrene values.
		Cadmium	<1 to 60	7.37	—	7.37	SS	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.
		Chromium III	<1 to 300	267	—	267	SS	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/kg) used for plants.
		Chrysene	<1	7.9	—	7.9	SS	No TRV for plants, reptiles or birds.
		Copper	≤1 to 20	1,900	—	1,900	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Indeno(1,2,3-cd)pyrene	<1	4.6	—	4.6	SS	Used benzo(a)pyrene values.
		Lead	<1 to 20	725	—	725	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	<1 to 7	1.97	—	1.97	SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	1 to 3	85.1	—	85.1	SS	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants (HQ for plants only).
		Pyrene	<1	24	—	24	SS	No TRV for plants, reptiles or birds.
		Selenium	<1	0.543	—	0.543	SS	No TRV for reptiles. SBC (1 mg/kg or 0.1 mg/L) used for plants.
		Silver	<1 to 10	19.4	—	19.4	SS	No TRV for reptiles or birds. SBC (2 mg/kg or 0.1 mg/L) used for plants. (HQ for plants only.)

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Zinc	<1 to 6	302	—	302	SS	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.
CFA-15	Dry Well (CFA-674) 3.00E-01	Copper	<1	21.1	—	21.1	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	<1	15.7	—	15.7	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	<1 to 1	0.42	—	0.42	SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants. (HQ for plants only.)
CFA-17/47[c]	Fire Department Training Area, bermed and Fire Station Chemical Disposal 1.96E+03	Benzo(a)pyrene	<1	0.137	—	0.137	SS	No TRV for plants, reptiles or birds.
		Benzo(b)fluoranthene	<1	0.2	—	0.2	SS	No TRV for plants, reptiles or birds.
		Benzo(g.h.i)perylene	<1	0.16	—	0.16	SS	Used benzo(a)pyrene values.
		Xylene[f]	≤3 to 10	6.9	—	6.9	S	No TRV for reptiles or birds. SBC (100 mg/L) used for plants.
CFA-21	Fuel Tank at Nevada Circle (S by CFA-629) 7.00E+00	TPH	≤1 to 3	54,000	—	54,000	SS	No TRV for reptiles.
CFA-23	Fuel Oil Tank at CFA-641 1.11E+01	TPH	<1	100	—	100	SS	No TRV for reptiles.
CFA-24	Fuel Tank at Nevada Circle (S by CFA-629) 2.04E+01	TPH	<1	2,600	—	2,600	SS	No TRV for reptiles.
CFA-26	CFA-760 Pump Station Fuel Spills 1.12E+02	TPH	≤1 to ≤4	3,470	—	3,470	SS	No TRV for reptiles.
CFA-27	Fuel Oil Tank at CFA-669 9.28E+00	TPH	<1	1,100	—	1,100	SS	No TRV for reptiles.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-28	Fuel Oil Tank at CFA-674 (west) 8.00E+01	TPH	<1	57.4	0.0	57.4	SS	No TRV for reptiles.
CFA-30	Fuel Oil Tank at CFA-665 2.08E+01	TPH	<1	76	0.0	76.0	SS	No TRV for reptiles
CFA-31	Waste Oil Tank at CFA-754 2.52E+01	TPH	<1 to 1	5,610	5,610	—	SS	No TRV for reptiles.
		Xylene	<1	6.69	—	6.69	SS	No TRV for reptiles or birds. SBC (100 mg/L) used for plants.
CFA-34	Diesel Tank at CFA-674 (south) 7.43E+00	TPH	<1	290	—	290	SS	No TRV for reptiles.
CFA-37	Diesel Tank at CFA-681 (south) 5.94E+00	TPH	<1	180	—	180	SS	No TRV for reptiles
CFA-38	Fuel Oil Tank at CFA-683 7.56E+01	TPH	<1	427	—	427	SS	No TRV for reptiles.
CFA-40	Returnable Drum Storage (south of CFA-601) 5.40E+02	TPH	≤1 to 3	<625	—	625	S&SS	No TRV for reptiles.
CFA-41	Excess Drum Storage (south of CFA-674) 6.97E+03	TPH	<1 to 20	<1,000	1,000	1,000	S&SS	No TRV for reptiles.
CFA-43	Lead Storage Area 1.53E+04	Lead	≤1 to 300	180	180	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02mg/L) used for plants.
CFA-44	Spray Paint Booth Drain (CFA-654) 9.24E+00	Lead	<1 to 1	51.1	51.1	5.8	S&SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
CFA-45	Fuel Oil Tank (CFA-605W) 1.49E+00	TPH	<1	<1,000	1,000	1,000	S&SS	No TRV for reptiles.

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Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-48	Chemical Washout Area south of CFA-633 9.29E+00	Lead	<1	43.1	43.1	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	<1	0.18	0.18	—	S	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
CFA-51	Dry Well at north end of CFA-640 1.00E-01	Cadmium	<1 to 5	14.0	—	14.0	SS	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants. (HQ for plants only.)
		Copper	≤1 to 3	250	—	250	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants. (HQ for plants only.)
		Lead	<1	37.0	—	37.0	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Selenium	<1	0.60	—	0.60	SS	No TRV for reptiles. SBC (1 mg/kg or 0.1 mg/L) used for plants. (HQ for plants only.)
		Zinc	<1 to 7	340	—	340	SS	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.

a. S = surface, i.e., 0 to ≤0.5 ft
   SS = subsurface, i.e., >1 to ≤0.5 ft

b. SBCs from Will and Suter 1995.

c. — = not calculated.

d. 95% UCL used in the ERA

e. This is the average of two positive subsurface cadmium concentrations (2.0 and 2.5 mg/kg) at CFA-04

f. At CFA-1747 organic compounds were calculated using maximum concentrations.

g. Xylene was detected at 10 ft bgs.

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remaining concentrations and therefore drives the HQ. However, acetone is not expected to persist in the environment. The extent of contamination is from 0 to 10 ft.

CFA-04, pond near CFA-674, has HQs greater than 1.0 from exposure to metals and Aroclor-1254. The largest HQs resulted from exposures to cadmium, mercury, and vanadium. To a lesser extent, other contaminants of concern include arsenic, barium, chromium III, cobalt, copper, lead, nickel, and silver. The maximum concentrations of these contaminants were less than 2 times their respective background concentrations. The extent of contamination is from 0 to 7 ft.

CFA-05, CFA motor pool pond, has HQs greater than 1.0 from metals. The largest HQs resulted from exposures to cadmium, chromium III, and lead. The maximum cadmium concentration was 38.8 mg/kg with an HQ ranging from ≤ 1 to 10,000. The maximum chromium III concentration was 91.3 mg/kg with an HQ ranging from ≤1 to 1,000. The maximum lead concentration was 631 mg/kg with an HQ ranging from ≤1 to 1,000. To a lesser extent, other contaminants of concern include arsenic, barium, cobalt, copper, manganese, mercury, and nickel. The maximum arsenic concentration was 18.4 mg/kg. The maximum barium concentration was 434 mg/kg. The maximum cobalt concentration was 9.4 mg/kg. The maximum copper concentration was 342 mg/kg. The maximum manganese concentration was 767 mg/kg. The maximum mercury concentration was 1.2 mg/kg. The maximum nickel concentration was 37.1 mg/kg. The HQs ranged from ≤1 to 100 for copper; ≤1 to 80 for mercury; ≤1 to 20 for cobalt and manganese; ≤1 to 10 for nickel; and ≤1 to 1 for barium. Contamination is limited to the surface soil for arsenic, cadmium, chromium III, copper and mercury but extends to 10 ft for barium, cobalt, lead, manganese, and nickel.

CFA-06, lead shop (outside areas), had HQs greater than 1.0 from potential exposure to both arsenic and lead. The maximum arsenic concentration is 14.5 mg/kg with an HQ ranging from ≤ 1 to 10. The maximum lead concentration is 153, with an HQ ranging from ≤ 1 to 200. Contamination is limited to the surface soil.

CFA-08, sewage plant (CFA-691), septic tank (CFA-716), and drainfield, has HQs greater than 1.0 from exposure to metals. The largest HQs resulted from exposures to lead, mercury, and selenium. The HQs ranged from ≤2 to 30 for lead; ≤1 to 30 for mercury; and ≤ 2 to 20 for selenium. To a lesser extent, other metal contaminants of concern include arsenic, chromium III, copper, nickel, and silver. The HQs ranged from ≤1 to 10 for arsenic, copper, and nickel; ≤ 3 to 5 for silver; and < 1 to 2 for chromium. With the exception of selenium and silver, the maximum concentrations of the remaining metals are less than 2 times their respective background concentrations. Selenium is less than 5 times its background concentration. There is no background concentration for silver. The extent of contamination is between 0 and 10 ft.

CFA-10, transformer yard oil spills, has HQs greater than 1.0 from exposure to metals. The largest HQs resulted from exposures to cadmium, and lead. The HQs ranged from ≤1 to 2,000 for cadmium and ≤1 to 3,000 for lead. To a lesser extent, other metal contaminants of concern include antimony, arsenic, cobalt, copper, manganese, mercury, nickel, and zinc. The HQs ranged from <1 to 70 for copper and zinc; ≤2 to 30 for cobalt; ≤ 5 to 20 for manganese; <1 to 20 for nickel, < 1 to 8 for arsenic, and < 1 to 4 for antimony and mercury. The extent of contamination is in the surface soil.

CFA-12, two French Drains, (CFA-690) had exposures to pentachlorophenol; however, no TRVs are available for this contaminant. Also the exposure path is incomplete due to excavation and site restoration, therefore this site is eliminated from the ERA.

CFA-13, Dry Well (south of CFA-640), had HQs greater than 1.0 from potential exposure to metals and pyrene. The largest HQ resulted from zinc, < 1 to 453. For other contaminants of concern, the HQs ranged from <1 to 33 for lead; ≤ 1 to 20 for copper, 4 for silver, and < 1 to 2 for chromium III, mercury, and pyrene.

CFA-15, Dry Well (CFA-674), had an HQ less than 1.0 from potential exposure to copper (1). The HQ for mercury was 1. Therefore, this site is eliminated from the ERA.

CFA-17/47, fire department training area and fire station disposal, has an HQ greater than 1.0 from exposure to xylene (HQ ≤ 3 to 10). However, since this HQ results from one sample collected at 10 ft (3 m) bgs, this site is not anticipated to pose an ecological risk, therefore, this site will not be considered further in the ERA.

The four petroleum sites that had HQs greater than 1.0 were CFA-21 and CFA-40, with HQs of 3.0, CFA-26, with an HQ of 4.0, and CFA-41, with an HQ of 20. The extent of contamination is between 1 and 10 ft. At CFA-21, CFA-26, and CFA-40, mammalian herbivores, including pygmy rabbits, and mammalian and avian insectivores are potentially at risk from TPH contamination.

At CFA-41, avian insectivores including black terns are potentially are risk from TPH contamination.

CFA-43, lead storage area, has an HQ greater than 1.0 from exposure to lead (HQ ≤ 1 to 70). Contamination is limited to the surface soil.

CFA-44, spray paint booth drain, has an HQ less than 1.0 from exposure to lead. Therefore, CFA-44 is eliminated as an ecological concern at WAG 4.

CFA-48, chemical washout area, has an HQ less than 1.0 from exposures to lead and mercury. Therefore, CFA-48 is eliminated as an ecological concern at WAG 4.

CFA-51, dry well at north end of CFA-640, has HQs greater than 1.0 for both cadmium, copper, and selenium for plants only; screening benchmark concentrations from Will and Sutter (1995) were used. The extent of contamination is between 1 and 2.5 ft. Due to the limited size of this site ($1.0E-01$ m^2) limited plants will be adversely affected.

7.4.4 Discussion of Uncertainty

The WAG ERA, by definition, is a conservative approach to assess the potential for risk to ecological receptors from a particular WAG's contaminant sources. The WAG ERA incorporates levels of uncertainty that could either overestimate or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the WAG ERA incorporates various factors that are designed to be conservative rather than result in a conclusion of no indication of risk when actual risk may exist. Regardless, uncertainties exist that could affect the estimation of true risk associated with WAG 4. These are summarized in Table 7-20.

Principal sources of uncertainty lie within the development of an exposure assessment and toxicity assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor

Table 7-20. Sources and effects of uncertainties in the ecological risk assessment.

Uncertainty Factor	Effect of Uncertainty (Level of Magnitude)	Comment
Estimation of ingestion rates (soil and food)	May overestimate or underestimate risk (moderate)	Few intake (ingestion estimates used for terrestrial receptors are based on data in the scientific literature (preferably site-specific) when available. Food ingestion rates are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally from Beyer et al. (1987).
Estimation of bioaccumulation and plant uptake factors	May overestimate or underestimate risk and the magnitude of error cannot be quantified (high).	Few bioaccumulation factors (BAFs) or plant uptake factors (PUFs) are available in the literature because they must be both contaminant- and receptor-specific. In the absence of more specific information, PUFs and BAFs for metals and elements are obtained from Baes et al. (1984), and for organic compounds, from Travis and Arms (1988).
Use of human health exposure concentrations Estimation of toxicity reference values	May overestimate (high) risk May overestimate (high) or underestimate (moderate) risk	Exposure concentrations were derived from data obtained as a product of biased sampling of WAG 4 sites. Samples were generally obtained from areas where contamination was believed to greatest. To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Use of functional grouping	May overestimate (high) risk	Functional groups were designed as an assessment tool that would ensure that the ERA would address all species potentially present at the facility. A hypothetical species is developed using input values to the exposure assessment that represents the greatest exposure of the combined functional group members.
Site use factor	May overestimate (high) or underestimate (moderate) risk	Site use factor is a percentage of the site of concern compared to the home range. This is extrapolated from literature values and allometric equations, may vary from season to season and year to year depending on environmental conditions. It is highly uncertain.

ingestion rates, selection of acceptable HQs, estimation of site usage, and estimation of PUFs and BAFs. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. These uncertainties will likely influence risk estimates.

At this level of the ERA, HQs greater than 1.0 tend to be from nonradionuclide contamination. This is explained in part by the methods used to determine toxicity values. For radionuclides, the TRVs are based on effects to populations, while for nonradionuclides, the TRVs are based on effects to individuals. As such, the nonradionuclide toxicity data is more conservative than the radionuclide toxicity data.

In relation to extrapolations between individuals and populations, it is difficult to accurately predict ecological effects of toxic substances because of the complexity of the ecosystem. Most toxicity information comes from laboratory studies of single contaminant impacts on single species. Hence, there is a great deal of uncertainty in extrapolating controlled laboratory results to complex field situations and from one species to another. Single contaminant studies cannot predict the interactions of multiple contaminants with each other and with the ecosystem. Additionally, interactions of organisms with the ecosystem are complex and not easily predicted. Arsenic and mercury are the most common nonradiological ecological risk drivers at WAG 4. These metals show "potential risk" even at background concentrations. Hence, any indication of concentrations above background for these two metals will result in a potential risk. The background concentrations used for screening are from Rood et al. (1995). These background concentrations can be used to eliminate potential contaminants that are clearly at background levels. As discussed in Rood et al. (1995), because of spatial variation in background concentrations due in part to differences in soil types, exceeding the background limits does not necessarily mean that the site is contaminated. As such, there is reason to suspect that some of the sites determined to have potential risks from arsenic and mercury may actually be background risks. Furthermore, the presence of arsenic at WAG 4 is likely to be unrelated to site activities since there are no known CFA processes that included arsenic.

A number of data gaps were identified in the course of the ecological risk analysis that will be addressed in the OU 10-04 ERA effort. Few data are available for the invertebrate populations at the INEEL. Invertebrates are important links in dietary exposure for wildlife. There are insufficient ecological and toxicological data to adequately characterize the contaminant effects in the invertebrate component of the ecosystem. Such uncertainty will propagate into some of the other endpoint compartments, in particular those representing mammalian, avian, and reptilian insectivores. At the OU 10-04 level, this data gap will be addressed to the extent possible.

There are a number of T/E or sensitive species that could occur at WAG 4. In some cases, they are known to exist in close proximity to WAG 4 sites. The lack of information concerning the presence or absence of T/E and/or sensitive species in the vicinity of INEEL facilities, and at the INEEL in general, has been previously identified as an acceptable data gap.

Ecotoxicological data is recognized as one of the major uncertainties in ERA. As with human health risk assessments, the TRVs are updated as new information is available for use in INEEL ERAs. This is an ongoing effort that will continue throughout the ERA process at the INEEL. Several contaminants (e.g., arsenic) appear to be an ecological risk at soil concentrations that are typical of background concentrations for these metals at similar sites. However, they fail the background screen at the INEEL. To permit a more accurate assessment, these contaminants will be reviewed during the 10-04 ERA. At this time, a greater discussion on issues of background and these contaminants will be included.

Many of these uncertainties will be difficult to reduce without obtaining extensive site-specific information. As part of the 10-04 ERA effort, site-specific ecological sampling has been proposed to provide information concerning movement of contaminants through the ecosystem. This sampling will be directed at eliminating some of the uncertainty that is present in the WAG ERA. Currently, an assessment of the uncertainty of using functional groups is being performed, and it has been proposed that a combination of functional groups and individual species be used for the 10-04 ERA. This should allow a better understanding of the results of the risk assessment. The results of the WAG 4 ERA are summarized in Table 7-21 and sites and COPCs shown to have potential risk for ecological receptors are listed in Table 7-22.